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SIR WILLIAM HERSCHEL, 1738-1822*

By SIR FRANK DYSON

AT the age of thirty-five years, William Herschel, a distinguished and prosperous musician, was impelled to explore the heavens. He found a small telescope which he had hired insufficient for his needs, and with great skill and patience constructed larger and larger instruments. After his day's work, he spent a great part of the night observing the stars. The conclusions he drew from his observations were characterized by an originality, boldness and splendour of outlook which have placed him among the greatest astronomers. "We ought", he writes, "to avoid two opposite extremes. If we indulge in a fanciful imagination and build worlds of our own we must not wonder at going wide from the path of truth and nature. . . . On the other hand, if we add observation to observation, without attempting to draw not only certain conclusions, but also conjectural views from them, we offend against the very end for which observations ought to be made. I will endeavour to keep a proper medium; but if I should deviate from that, I could wish not to fall into the latter error."

Frederick William Herschel was born at Hanover on November 15, 1738. His father was a hautboy player in the Hanoverian Guards, and at the age of fourteen William was engaged as a musician in that regiment. He left in 1757, as he had taken no oath binding him to

*This article by Sir Frank Dyson, for many years Astronomer Royal, appeared originally in the British weekly scientific review, *Nature*, volume 142, November 12, commemorating the bicentenary of the birth of Sir William Herschel.

military service. He received a formal discharge in 1762. The legend that he deserted from the army, and received a pardon from George III in 1782, is a fiction.

Towards the end of 1757, Herschel came to England and for some time had hard work to earn a living by copying music and giving occasional performances. His musical abilities were gradually recognized, and in 1760 he was appointed instructor of the band of the Yorkshire Militia stationed at Richmond. In 1762 he resigned this post; he composed symphonies, conducted concerts at Leeds, was for a short time organist of the Halifax parish church, until in 1766 he became organist at the Octagon Chapel at Bath. He was soon the centre of musical activity in this fashionable watering place and had a busy life, composing, conducting concerts and taking pupils.

As music was not sufficient for his boundless energy, Herschel studied Italian, Greek, harmonics, mathematics, optics and astronomy. In 1773, he hired a small telescope and commenced to search the heavens. He soon wanted a larger telescope, and after many experiments and failures succeeded in making a Newtonian reflector of six and a half inches diameter and seven feet focal length. The parabolic mirror was of speculum metal in the proportion of 5 lb. of tin to 9 lb. of copper. He cast the disk himself, ground it and polished it with his own hands. With this instrument, he repeated and extended a previous survey of the heavens. His intention was to find bright stars with faint stars near them, on the supposition that the difference of magnitude was the effect of distance and might thus serve to determine stellar distances.

On March 13, 1781, Herschel made this entry in his note-book: "In the quartile near ζ Tauri, the lowest of the two is a curious either nebulous star or perhaps a comet". After several cloudy nights, he found on March 17 that the star had moved and was presumably a comet. He communicated his discovery to Maskelyne, the Astronomer Royal, who wrote to him on April 23: "It is as likely to be a regular planet moving in an orbit nearly circular round the Sun as a comet moving a very eccentric ellipsis. I have not seen any coma or tails to it". The evidence of its great distance and uniform movement soon showed that the body was, in fact, a new planet. This was an astounding discovery, as no one had ever imagined there could be

more than the five planets Mercury, Venus, Mars, Jupiter and Saturn, which had been known for ages. Herschel was awarded the Copley Medal of the Royal Society in November, 1781, and was elected a fellow of the Society in December.

The attention of George III was directed to the fame of the Hanoverian astronomer, with the result that Herschel was appointed King's Astronomer with a salary of £200 a year. He was now relieved of the necessity of snatching astronomical observations in the intervals of concerts or sitting up all night after a hard day's work. He had at this time a 7-foot telescope of 6 inches aperture and a 20-foot telescope of 12 inches aperture. He now proceeded to make a 20-foot telescope with an 18-inch speculum, and commenced his famous 'sweeps' to find what was in the sky and to gauge the depths of the heavens. Some years later, he constructed the great 40-foot telescope with a 40-inch speculum. Before he had made the flat mirror so as to use the telescope in the Newtonian form, he looked down the tube directly with his eyepiece and found the definition good, and the brilliancy greater owing to the absence of a second reflection. He accordingly adopted what is known as the "Herschelian" type of reflecting telescope in later work.

Herschel continued his observing with, if possible, increased vigour, finding in his 'sweeps' objects which enrich the natural history of the sky and classifying them according to their species, hundreds of double stars, thousands of clusters and nebulæ. Double stars attracted him because he hoped to find a parallactic displacement between a bright star and its faint neighbour, and thus obtain an idea of stellar distances. He published a list of 269 double stars in 1782, giving their position angles and their angular distances apart inferred roughly from the size of the disks. In 1784 he published a further list of 484 stars, with their distances apart now measured by a micrometer. He seems to have suspected that some of them might be real binary systems. By 1802 he was satisfied from the changes in position angle that a considerable number of these stars were binary systems moving in elliptic orbits under their mutual gravitation. Newton's law thus held in these distant regions in space.

In 1760 Mayer had indicated the perspective effect which would be shown in the proper motions of stars by the movement of the sun

in space, but had failed to find it. In 1783, from the proper motions of seven bright stars given by Lalande, Herschel determined that the sun was moving in the direction of λ Herculis. From a larger number of stars he obtained a slightly different and not quite so good a direction, as that found by later researchers from thousands of stars arranged in all manner of ways according to magnitude, size of proper motion, and type of spectrum.

Herschel's ideas about the physical nature of the sun now seem to us very extraordinary. He regarded it as a dark, cool, solid globe, possibly inhabited, protected by a layer of cloud from the light and heat of the upper luminous region. This solid part of the sun is revealed in the openings of the luminous region shown in sun-spots. This theory held the field for many years. Erroneous facts are harmful, but erroneous theories are better than none at all and act as incentives to better ones.

With his large telescopes, Herschel examined the planets. He discovered two satellites revolving around 'Georgium Sidus' or Uranus, and thus encouraged found two additional satellites of Saturn. He found that Venus was covered with clouds, noticed the changes in the white spots at the poles of Mars, and concluded that Mars was most like the earth as regards habitability. He determined the direction of the axes, periods of revolution and oblateness of the planets. He found that a spot in the atmosphere of Jupiter had a different period of revolution from the rest of the planet.

Herschel's name is inseparably associated with great telescopes, but for the years 1795-97 he interrupted his work to arrange the stars in different constellations, according to their magnitudes. This was largely done with the naked eye. The work was not estimated at its full value until Prof. E. C. Pickering reduced and discussed the observations. "Herschel furnished observations of nearly 3,000 stars from which their magnitudes a hundred years ago can be determined with an accuracy approaching that of the best modern catalogues".

Herschel was attracted by Messier's short list of nebulæ and clusters published in the *Connaissance des Temps* for 1783. In the belief that all nebulæ could be resolved into stars, he commenced a survey of the whole sky with his new 20-foot reflector of 18 inches aperture. At the same time, by counting the number of stars in equal

areas in different parts of the sky, he purposed to 'gauge' the depth of the sidereal universe. He began these famous 'sweeps' of the heavens on October 28, 1783. He first placed his telescope in the meridian, and standing in a gallery at the end of the telescope could give it a motion in azimuth of 10° or 12° either way. He moved the telescope slowly backwards or forwards and noted what he saw. He then changed the telescope 8′ or 10′ in altitude. Twenty or thirty of such operations he called a 'sweep'. They were very fatiguing and spoiled the sensitiveness of his eye for faint objects. After the forty-first sweep he discarded this method and had recourse to vertical sweeps, employing a workman to move the telescope, and calling out his observations to his sister Caroline, who noted them down. In 1789 he published a catalogue of 1,000 clusters and nebulæ. "As a mere explorer of the heavens," wrote Agnes Clerke, "his labours were prodigious. He discovered no less than 2,500 nebulæ, 806 double stars, and passed the whole firmament in review four several times, and counted the stars in 3,400 *gauge* fields."

In these 'gauges', Herschel counted the number of stars in the field of view of his eyepiece, which had a diameter of 15′. His telescope revealed all the stars to about the fourteenth magnitude, at least a thousand times as faint as the faintest star visible to the naked eye. He found that the number of stars diminished with increasing distance from the Milky Way until they were only one thirtieth of the number at its pole. He was thus led to the 'grindstone' theory of the 'Construction of the Universe'. His views were modified in his later papers in 1811 and 1814 and he realized that the Milky Way is more complex, and that nebulæ are not always irresolvable clusters. "We may have surmised nebulæ to be no other than clusters of stars disguised by their very great distance, but a longer experience and better acquaintance of their nature will not allow of such a principle." He gave the name "planetary nebulæ" to bodies "which, notwithstanding their planetary aspect, retain a haziness by which they are surrounded and evinces their nebulous origin." He regarded the Orion nebula as true nebulosity and typical of other extended nebulæ, but retained his belief that some nebulæ were resolvable into stars and were comparable in size with our own Galaxy.

Only the briefest reference can be made to an important paper

published in 1800, when he discovered that "the heat derived immediately from the sun or from candescent terrestrial substances, is occasioned by rays emanating from them; and that such heat-making rays are subject to reflexion and refraction". He gives in a diagram the intensity of the heat in what we should now call all wave-lengths extending from the infra-red to the violet.

We must on no account overlook the help Herschel received all his life from his devoted sister Caroline. From 1772 she was his constant companion, housekeeper and assistant in his music and astronomy. She accompanied him to Slough and would sit up whole nights taking down his observations and copying them out the following day. When William married she took lodgings in Slough and still continued as his assistant. At her brother's suggestion, she searched for comets and discovered no fewer than eight. After Herschel's death she returned to Hanover and prepared a catalogue of 2,500 nebulæ and clusters discovered by him. For this she was awarded the Gold Medal of the Astronomical Society. She died in 1848 after a prolonged and cheery old age.

On May 8, 1788, Herschel married Mary, daughter of Mr. Adee Baldwin, a merchant of the City of London, and widow of John Pitt, Esq. Their son John was born on March 7, 1792. Mrs. Herschel was of an amiable and gentle character and lived on friendly terms with Caroline, whom she had displaced. In 1791, Herschel visited Glasgow and was given the freedom of the City and a doctorate of laws by the University, and on his return called on Michell, an astronomer of distinction and originality. In 1802 he went to Paris and met Messier, Delambre, Laplace, Count Rumford and Napoleon. In 1816 he was knighted by the Prince Regent. In 1820, when the Astronomical Society was founded, he was made its first president. He was too feeble to attend the meetings, but allowed his last paper to be published in the Memoirs of the Society. He died at Slough on August 25, 1822, and was buried in the Church of St. Lawrence at Upton.*

*In the preparation of this article, I have used to a great extent the admirable introduction to "The Scientific papers of Sir William Herschel" written by Dr. Dreyer, and am also indebted to a conversation with Dr. W. H. Steavenson.—F. W. D.

THREE AMERICAN MATHEMATICIANS*

By George D. Birkhoff

AT the very outset it is well to recall the general mathematical background of our country at the time when the society came into existence. In colonial days scientific and mathematical knowledge had a certain definite standing, largely for its practical value but in part also for its own sake. George Washington was a scientifically minded gentleman farmer for much of his life, and in his youth was a skilled surveyor, familiar with trigonometry; Benjamin Franklin discovered experimentally the electrical nature of the lightning discharge, theorized concerning electricity as a fluid, and had enough mathematical interest to devise ingenious magic squares; Thomas Jefferson regarded geometry and trigonometry as "most valuable to every man," algebra and logarithms as "often of value," while he classed "conic sections, curves of the higher orders, perhaps even spherical trigonometry, algebraic operations beyond the 2nd dimension, and fluxions" as a "delicious luxury"; in his later years Jefferson spent much of his time in mathematical reading, and was ever a true friend of mathematics. The interest in science and mathematics continued to be genteel and amateurish among American scholars and devotees until towards the middle of the last century, with few notable exceptions. The best mathematicians of those days looked appreciatively toward Europe without much thought of high emulation.

Then came a gradual change in the temper of the times, which led to the formation of our society. Characteristic of this change were the outstanding figures of Benjamin Peirce, of Josiah Willard Gibbs and of George William Hill. Peirce died in 1880, Gibbs in 1903 and Hill in 1913, having been fourth president of the society in the years 1894 to 1896. But it was the contagious enthusiasm of a group of young Americans, returning from mathematical studies in Europe,

*Part of an address on "Fifty Years of American Mathematics" at the semi-centennial celebration of the American Mathematical Society, New York City, September 1938. Reprinted from *Science* for November 18, 1938.

which proved the immediate cause of the formation of our society; and in this so important enterprise Thomas Scott Fiske, seventh president of the society, and Frank Nelson Cole, long its devoted secretary, took leading parts. The year 1888 of our beginning as a professional body devoted to the interests of research marks with precision our coming to a fitting mathematical position among the nations of the earth.

Of the three figures mentioned it was Benjamin Peirce who was by far the most influential in America as a scientific personage. I remember a talk about Peirce with his last pupil, the late Dr. Leonard Waldo, mathematical meteorologist. Waldo said that the first sight of Peirce seated behind his desk at home rendered him quite speechless. Ex-President A. Lawrence Lowell, of Harvard University, fell under Peirce's mathematical spell while an undergraduate and wrote a few years ago: "Looking back over the space of fifty years since I entered Harvard College, Benjamin Peirce still impresses me as the most massive intellect with which I have ever come into close contact, and as being the most profoundly inspiring teacher that I ever had. His personal appearance, his powerful frame and his majestic head seemed in harmony with his brain."

Benjamin Peirce's papers on "Linear Associative Algebra," announced at the first meeting of the American Association for the Advancement of Science in 1864, give him a just claim to be considered an eminent mathematician. His researches in this field were made at a time when English and American mathematicians looked upon the great invention of quaternions by W. R. Hamilton as a supreme achievement, destined to be of incalculable importance for mathematics and physics. Peirce saw more deeply into the essence of quaternions than his contemporaries, and so was able to take a higher, more abstract point of view, which was algebraic rather than geometric. However, he was much more than an algebraist, for he was well informed about some of the most significant mathematical developments of his day. His volumes, "Curves, Functions, and Forces," testify to a real interest in the function-theoretic work of Cauchy, albeit somewhat superficial in character. His large book, "Analytical Mechanics," showed that he had read and mastered the works of Hamilton, Jacobi and others in the extensive field of

dynamics. In addition, he was skilled in the theory and methods of computation useful for dynamical astronomy, and spent a considerable amount of time during later years in a somewhat unhappy attempt to show that Leverrier and Adams had no adequate basis for the calculations leading to the celebrated discovery of the planet Neptune; one naturally calls to mind the calculations by the eminent astronomer, the late Percival Lowell (brother of A. Lawrence Lowell), which brought about the discovery of the small planet Pluto in 1930, since these calculations have also been occasionally criticized for similar reasons.

Despite Peirce's remarkable ability to inspire especially capable and advanced students, he was not regarded as a good teacher for the rank and file; a characteristic feature of his lectures was a reaching toward seemingly endless vistas of abstract generalizations.

Josiah Willard Gibbs was a man of modest and not especially impressive personality, who did far more to advance physics and chemistry through his work on statistical mechanics and the equilibria of chemical systems than Peirce ever did for pure mathematics. Gibbs's title to be considered a mathematician rests mainly upon his largely notational contributions to vector analysis, a subject also closely related to Hamilton's quaternions. The late Maxine Bôcher, who with William Fogg Osgood really succeeded Peirce at Harvard, later attached the name of "Gibbs's phenomenon" to a fundamental fact about Fourier's series which was observed by Gibbs; this is related to the peculiar behavior of the successive curves of approximation $y=s^n(x)$ to a discontinuous function near the point of discontinuity. As has happened from time to time here and elsewhere, the fundamental contribution of Gibbs's physical work was first recognized by admirers in other countries, in particular by James Clerk Maxwell, so that it was only somewhat tardily, by reflected light as it were, that Gibbs came to be properly appreciated in the United States.

George William Hill was a scientific figure of altogether unconventional type who spent more than three decades of his life as an assistant in the Nautical Almanac Office in Washington and then went back to the place of his birth, West Nyack, N.Y., to continue his researches. Hill, like Gibbs, never married. His life was devoted

to what were essentially mathematical studies of the solutions of the three-body problem useful to the lunar theory and in making specific astronomical computations. His work on periodic motions was the worthy forerunner and inspiration of the splendid theoretical advances of Henri Poincaré in celestial mechanics, who thus owed much to Hill's achievements. The free introduction of infinite determinants by Hill in his celebrated papers on the restricted problem of three bodies was especially noteworthy, although it is only recently that this interesting analytic instrument has been perfected.

Of these men, Hill would be claimed for themselves by the theoretical astronomers, along with Nathaniel Bowditch, translator and commentator of Laplace's "Mécanique Céleste," and Simon Newcomb, great perfecter of lunar and planetary theory; while Gibbs would be justly taken by physicists and chemists for their own. Thus there remains to the mathematicians of America only Benjamin Peirce for their undisputed possession. He appears as a kind of father of pure mathematics in our country. In his deep appreciation of the elegant and abstract we may recognize a continuing characteristic of American mathematics. In his concern with its many applications there resides a virtue which we are finding it more difficult to realize, because of the trend towards professional specialization. Without doubt, however, there is a spiritual necessity upon us to-day to regain a similar breadth of outlook.

AN ACCOUNT OF AURORAL PHENOMENA OBSERVED IN WESTERN CANADA

By H. Edward Stumbles

TEN years ago, late in July or early August 1928, I had the unusual experience of observing an auroral display when the curtains of the aurora were very close overhead, and streamers extending from the curtains reached to and came in contact with the ground in my immediate vicinity. This occurred near Smiley, Sask., Township 31, Range 25, West of the 3rd Meridian, where the country is open prairie-land, and forms part of a plateau situated between the North and South Saskatchewan Rivers, with an altitude of 2300 ft. at my point of observation. It was a calm, warm summer night, with not more than a drift in the air, the air at that time being free from dust storms, smoke from forest fires, and mist and dampness other than normal night moisture.

On leaving the house at about one a.m. I was surprised to see that the aurora was surrounding me in all directions, as far as I could see, (nearly half a mile). Some streamers extending from the curtains reached to the ground, and others nearly so. Several, a dozen or more, were in contact with the ground within a radius of a hundred yards from me. Overhead the sky appeared to be full of clouds of luminous material, with a frequent ascending and descending movement. Whilst watching this general effect, I saw a streamer drop from the curtain and make contact with the ground less than 50 yards from where I stood, dropping at a speed comparable with that of falling water, and the angle from me to where it left the curtain was about 25 degrees. There was no distribution of material short of this point of contact with the ground, but to the leeward of the streamer, patches of luminous material formed and drifted in the air, and faded out in the course of a few seconds; this continued for a distance of about 25 yards, and then a patch of luminosity formed close to the ground, and rose with a swift upshooting movement and joined the curtain above, forming a streamer similar to the one that descended. The patches then ceased to form, and

both these streamers appeared as being in a state of wavering suspension like unto the other streamers, as shown in the accompanying sketch.

Here the streamers and consequently the patches, are shown rather closer together than should be; the small patches to the right are on the windward side, and can be looked on as forming near the descending streamer, those near the centre as being fully formed, and those to the left and leeward as fading out near the descending streamer. The direction is looking east and slightly south.

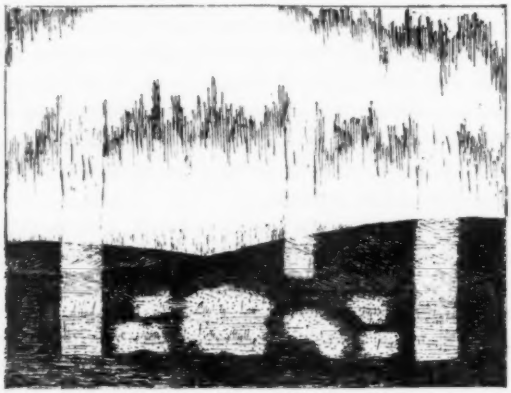

Fig. 1.—The patches of luminosity shown above formed after the descent of a streamer to the ground, following which there was the appearance to the leeward of a streamer ascending from the ground and joining the curtain above. The patches then ceased to form; the descending and ascending movement was only temporarily apparent, and when the movement was complete both the streamers appeared to be in a state of waving suspension. Both the streamers and the patches were transparent, and the hill in the background a dozen rods away, was distinctly visible through intervening streamers.

A little later following the descent of a streamer directly to my windward, a number of patches of luminosity drifted past me within a distance of a yard or two. Some were near the ground, some level with my horizontal line of sight, and some considerably higher. These patches of luminosity consisted principally of tiny sparks or dots of light, that were interspersed with groups of needlelike darts of light, that appeared to be both ascending and descending at intense speed,

the effect being very like a "brush-discharge"; also there were some lone darts of light similar to particle tracks, and ranging from one to three inches in length; all these tracks were vertical, whilst the patches moved bodily in a horizontal direction at about a walking pace, which was in keeping with the air drift or *very* light wind. When close the ionisation was audible in the form of a faint "crickling" or "spittering" sound, similar to a weak electrical sparking such as obtained by stroking a fur animal, and was too faint to be heard at a distance. On one occasion a feeling of warmth to my windward cheek was suspected.

Following this, whilst standing in the dark of my stable watching the display through the open door, I heard very distinctly, a crickling sound overhead, my attention was then directed to a vent about half an inch wide and a foot long in the board roof overhead. Here luminosity in the form of strings of sparks was entering, and penetrated to a depth of an inch or two down to about a foot, the depth changing erratically and at a speed that was readily followed by the eye. Thinking of the danger of fire, and knowing there was a similar vent in another part of the roof, I also found a leakage of luminosity there, and by climbing on the manger and feeling where the sparks entered, I satisfied myself of there being no feeling of heat that could possibly cause ignition. On looking at the roof outside, I noticed that part of a streamer terminated on the roof, where again there was no distribution of luminosity short of the point of contact, and the remainder of the streamer wide of the roof, continued to the ground.

There was no sign of colour on this occasion, the luminosity I observed being entirely white. The general illumination was about that of moderate moon-light, with spaces between the places occupied by the luminosity showing comparatively dark. I experienced no feeling of electrification and doubt if such could have been detected without instruments. I had not noticed any sign of auroral light prior to retiring at about 9.30 p.m. I watched the phenomena, I would say, rather more than half an hour, during which time there was no general change of either increase or abatement; and at daybreak conditions again appeared to be quite normal.

2050 Yew St.,
Vancouver, B.C.

TWENTY-SEVENTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

By D. W. Rosebrugh

THE twenty-seventh annual meeting of the A.A.V.S.O. was held at Harvard Observatory, Cambridge, Mass., on October 14 and 15 through the kind invitation of Dr. Shapley, Director, who was himself, however, absent at the Harvard Observatory at Bloemfontein, South Africa. Some fifty or sixty members and friends attended the meeting from the eastern United States and Canada and it was particularly pleasant to welcome Miss Patterson and Mr. McRae of the David Dunlap Observatory who are studying at Harvard this year.

The Bond Astronomical Club entertained the A.A.V.S.O. on Friday night. Dr. Donald H. Menzel stated that the sensation of the recent I.A.U. meetings at Stockholm was Dr. Lyot's report of his work with the coronograph on the Pic du Midi in France. Dr. Lyot has greatly improved his equipment since his work was first described in this Journal some years ago. He can now photograph the inner corona without an eclipse and his direct pictures of prominences confirm those taken with the spectrohelioscope at the McMath-Hulbert Observatory. It is fortunate that this independent check exists for such remarkable phenomena have been photographed with the spectrohelioscope that some astronomers have believed that Doppler shifts in the lines might be introducing errors in the spectrohelioscopic pictures. The most unexpected discovery is that clouds of incandescent vapors apparently form or condense high above the surface of the sun and are drawn swiftly down into sunspot vortices lying far below on the surface of the sun by some force not yet identified.

Miss Dorrit Hoffleit of Harvard stated that the meteor section of the I.A.U. discussed the relation between the Zodiacal light and meteors. Dr. Groot of Czechoslovakia is issuing bigger and better meteor charts, while Prof. Swoboda is continuing his experiments upon observing artificial meteors to attempt to evaluate the "personal equation".

The Saturday morning session was devoted to the reports of the Recorder, Treasurer, Chart Committee, Occultation Committee, and Nova Search Committee of the Association. These reports showed a healthy growth in activity. Mr. Leon Campbell, Pickering Memorial Astronomer and Recorder, said that for the first time the annual number of observations made exceeded 60,000. One hundred and sixty-two observers contributed to this total, Signor Eppe Loreta, Italy; Mr. Eugene H. Jones, New Hampshire; Mr. Walter Scott Houston, Milwaukee; and Mr. Ferdinand Hartmann, Long Island, N.Y., having submitted 4,700, 4,248, 3,860 and 2,700 observations respectively while the 98 tail-enders nevertheless contributed an aggregate of 10,000 observations or one sixth of the total.

Dr. Dirk Brouwer of Yale spoke briefly upon the life work of the late Dr. Ernest W. Brown of Yale, past-president of the A.A.V.S.O., who was the foremost world authority on lunar theory.

Dr. Dirk Brouwer, Mr. Leo J. Scanlon, Pittsburgh; Mr. Joseph W. Meek, Tucson, Arizona; and Mr. Joseph L. Woods, Baltimore, were elected councillors for 1939-40, and Mr. Elmer, Mr. Witherell, Mr. Campbell and Mr. Rosebrugh were reelected President, Treasurer, Recorder and Secretary respectively for 1939. Dr. Helen Sawyer Hogg, David Dunlap Observatory, was promoted to the First vice-presidency and Dr. Brouwer was elected to the Second vice-presidency. It was decided to hold the 1940 May meeting in Toronto upon the invitation of the Toronto Centre of the R.A.S.C., and Mrs. Hogg, the vice-president of the A.A.V.S.O.

Mrs. Shapley entertained the Association at luncheon on Saturday in the Observatory Residence.

On Saturday afternoon Mr. Ed. Halbach described the completed observatory of the Milwaukee Astronomical Society. This houses 13″ and 8″ reflectors and Mr. Prinslow has laid out a comprehensive and efficient observing schedule for the sixty members of the M.A.S. to follow. Miss Margaret Harwood, Nantucket, presented a paper on the variable star DF Cygni which is of the RV Tauri type and resembles V Hydrae. This star has a short term period of variation of 49.8 days, a longer period of 782 days and a third period of 30 years. It has taken 50 years of photography to discover the third period of some of these RV Tauri stars. Dr. Cecilia Payne Gaposch-

kin and Dr. Sergei Gaposchkin briefly outlined their important new book on variable stars. Miss Jenka Mohr stated that their classification of variable stars would probably supersede Ludendorff's ten classes as reported in the R.A.S.C. Observer's Handbook. Dr. and Mrs. Gaposchkin also discussed their recent studies and the first fruits of the Variable Star Photographic Bureau which is studying 2,000 variable stars as shown on the Harvard photographic plates of the last fifty years, to supplement the visual work of the A.A.V.S.O. It is found that RW Lyrae is a regular variable star with a period of 85 days. Previously no regular variable stars were known with periods lying between 65 and 100 days, representing the longest period of the long-period cepheid group and the shortest period of the long-period regular star group, respectively. Although Beta Lyrae has been intensively studied since its discovery 154 years ago some of the peculiarities of its smoothly varying double minimum light curve still are puzzling. It is now considered to be a rotating close double system the components of which are ovaloid. Periodic eclipses account for the main features of the light curve. Obscuration accounts for some of the details and it is now thought that librarian of the elongated components may account for some hitherto unexplained details of the light curve.

Movies of the nearly completed dome of Mt. Palomar Observatory were shown.

Miss Cannon, Miss Henrietta Swope, Mr. Elmer and Dr. Robert H. Baker gave after dinner talks at the Saturday night banquet. Dr. Baker, Director of the Observatory and Head of the Astronomical Department of the University of Illinois, described his recent visit to the island of Tycho Brahe. But little evidence of Tycho's observatories now remain and very regrettably his instruments have been dispersed and destroyed. Miss Cannon and Miss Swope talked about the social events of the I.A.U. meetings and President Elmer showed slides of the attending astronomers.

Poughkeepsie, N.Y.

METEOR NEWS

Observations relating to meteors and meteorites are cordially invited.

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PETER M. MILLMAN,
David Dunlap Observatory,
Richmond Hill, Ont.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Scientific Activity at San Miguel, Argentine Republic

The director of San Miguel Observatory, Ignacio Puig, S.J., shows continued activity in issuing various publications designed to spread throughout his great country a knowledge of astronomy and related sciences. Publication 5 deals with the eclipse of the sun on May 29, 1938; No. 6 with Cosmic Rays; No. 7 with the Zeiss Planetarium. These are reprints of lectures. No. 8 consists of twenty-five articles contributed to "El Pueblo" of Buenos Aires during 1936 and 1937. They deal with present-day topics, such as, Peltier's Comet, Reform of the Calendar, Position of the Sun in the Milky Way, Expansion of the Universe, etc. Any one who uses the Spanish language would find them interesting reading, and Director Puig is to be complimented for his excellent efforts to supply the people with scientific information.

Astronomy at the A.A.A.S. Meeting

Professor Stetson, Secretary of Section D (Astronomy) of the American Association for the Advancement of Science, writes:

The American Association for the Advancement of Science is holding its scheduled meeting this year at Richmond, Virginia, December 27-31. Meetings of the astronomical section (D) are scheduled for Tuesday and Wednesday, December 27 and 28. The Tuesday afternoon programme will be devoted to a joint session of Sections D and E for a symposium arranged by Section E and the American Geophysical Union, in which important problems relative to the earth sciences will be presented.

There will be general sessions for contributed papers on Wednesday morning and afternoon. The Wednesday morning programme will include the address of the retiring Vice-President of the Section, Dr. Philip Fox of the Museum of Science and Industry, Chicago. Through the invitation of Professor S. A. Mitchell, Director of the Leander McCormick Observatory of the University of Virginia, there will be opportunity for those attending the Section D sessions to visit the observatory. Plans are being made for a dinner of the section. It is anticipated that this will be held at the Jefferson Hotel at six o'clock on Tuesday evening, December 27.

C. A. C.

MEETINGS OF THE SOCIETY

AT VICTORIA

May 11, 1938.—A regular meeting of the Victoria Centre was held in the Y.W.C.A. Parlours at 8:15 p.m. with the president, Mr. Gordon Shaw, in the chair. As this meeting was the last regular meeting of the Spring Session, the President reminded members that the Summer Course would commence as usual in July. It was announced that an extraordinary meeting of the Victoria Centre will be held Thursday, May 26, when Victorians will be privileged to hear Professor W. R. Brode lecture on the 1936 eclipse expedition to Siberia, and to see films taken of the solar eclipse. The vice-president, Mr. R. Peters, described present positions of the planets and noted several interesting points in connection with the total eclipse of the moon to take place Friday, May 13.

The meeting took the form of a symposium on the new 200-inch telescope soon to be completed for Mt. Palomar.

Mr. James Smith discussed as the first phase of the work the construction and mounting of the telescope. This speaker outlined a few of the problems confronting those who were working with the enormous instrument. Various interesting points were discussed regarding size, weight and purpose of the auxiliary apparatus.

Mr. William Petrie, the second speaker, took as his topic the new telescope and its relation to the solar system. Mr. Petrie described first the increased resolving power of the telescope as well as the greater light gathering power. Because of these, more details about the surface of the moon will be available, the question of the "canals" of Mars may finally be cleared up, more truth will be apparent about satellites of various planets and the "lost satellite" of Jupiter. There is the possibility of a planet beyond Pluto. Powerful spectroscopes and a more dispersed spectrum will reveal more information about atmospheres of the planets.

The third speaker, Miss Phoebe Riddle, discussed the expectations in the field of stellar astronomy. The greater light grasp of the giant eye will reveal more facts about external galaxies, and hence many problems such as the rotation of the galaxy, theories of cosmogony and relativity, and problems connected with atomic energy and double star astronomy may be at least partially solved.

Mr. Boyd Brydon gave a few interesting points in connection with the mounting of the new telescope, explaining how that type of mounting had been devised by a dentist (Dr. H. Page Bailey), an amateur astronomer.

October 5, 1938.—A regular meeting was held in the Y.W.C.A. Parlours. The meeting came to order at 8.15 p.m. with the President, Mr. Gordon Shaw, in the chair. Mr. Boyd Brydon told members that a set of several volumes of Royal Astronomical Society of London Monthly Notices had been presented to this centre by Sir Frank Dyson. Miss Hailstone, the librarian, gave titles

of several other books that have recently been added to our library, and urged members to make greater use of these books. Six new members were welcomed to the Society: Mr. Brian Harrison, Mrs. J. A. Bland, Mr. James M. McCutcheon, Mrs. Nora Pepler, Mr. S. P. McKellar, Mrs. U. Ley. The President announced that the telescope-making section will again become active under the direction of Mr. Leonard Hopkins.

The speaker of the evening was Dr. R. M. Petrie, who had chosen as his topic, "Celestial Kinematography". Celestial kinematography, explained the speaker, is the application of motion picture work to astronomical objects. It is particularly opportune to discuss the topic at this time as 1938 marks the first decade of the first successful attempt to reproduce the properties of motion. The motion picture medium in astronomy has a definite and important educational value: it brings to the fore a realization that astronomy is a dynamic subject, it shows the motions of the heavenly bodies with the time factor compressed, and will automatically introduce a wider field of education. But its scientific value is not to be disregarded, explained Dr. Petrie, as this work is well suited to attack astronomical problems of several different sorts.

The speaker next outlined the historical development of celestial kinematography. Dr. McMath, in 1927, first attempted a motion picture of the moon. Out of this first experiment came the desire to perfect the making of celestial motion pictures, and subsequent plans resulted in the building of the McMath-Hulbert Observatory, now a part of the University of Michigan Observatory. Dr. Petrie then discussed a few of the many problems to be overcome in the successful application of the motion picture camera to astronomical work.

Films were presented which showed much of the apparatus at the McMath-Hulbert Observatory and which gave a very clear presentation of the different types of solar prominences.

Mr. R. Peters moved a vote of thanks to Dr. Petrie, the audience concurring heartily.

P. RIDDLE, *Recorder.*

AT TORONTO

September 27, 1938.—A very successful open-air meeting was held on the campus of the University of Toronto on Tuesday, beginning at 8.30 p.m. The large number present were favoured by the absence of clouds, while during the whole evening the greater part of the sky was covered by an unusual display of the Aurora Borealis. The ever-changing forms, with at times, strong colour effects provided an absorbingly interesting spectacle.

Mr. G. H. Tidy had charge of the 6-inch telescope in the observatory, while on the lawn were Mr. T. E. Cannon with a smaller refractor, and Mr. Buick with a 6-inch reflector. In the earlier part of the evening Venus and the moon were viewed; later Jupiter and Saturn were well placed for observation. During the evening one of Jupiter's satellites was observed to disappear behind the planet.

October 11, 1938.—The first of the autumn series of meetings was held at the David Dunlap Observatory, Richmond Hill, by the courtesy of the Director, Dr. R. K. Young and staff, at 8 p.m. The members met in the lecture hall, Mr. E. J. A. Kennedy in the chair.

Dr. Helen S. Hogg spoke on the planet Jupiter, and with the aid of slides made during recent months showed the present maximum phase of the periodic high colouring of the planet, and gave information about the two newly discovered satellites, Nos. 10 and 11. They are about magnitude 19 at opposition; the period of No. 10 is about 260 days.

Dr. J. F. Heard spoke on the planet Saturn, indicating what the members might expect to see through the telescope.

Programmes of the autumn meetings were distributed to all present. The members were then permitted to visit various parts of the buildings, to examine the transparencies and other objects of interest, to visit the domes and to look through the telescopes.

In the great dome Dr. F. S. Hogg was in charge of the 74-inch reflecting telescope which was set on Jupiter in the earlier part of the evening and later on the Ring Nebula in Lyra. Dr. Heard was in charge of the 19-inch showing Saturn. Dr. Millman had two portable refractors on the lawn where Jupiter and other objects were viewed through these. As the evening was mild and the air very still the seeing was good.

Refreshments served in the usual R.A.S.C. manner brought to a close a pleasant and thoroughly enjoyable evening.

October 25, 1938.—The regular meeting was held in the McLennan Laboratory, University of Toronto, at 8 p.m. In the absence of the Chairman, Mr. S. C. Brown, Vice-Chairman, occupied the chair.

The following were elected members of the Society:

Mr. Alex. Macdonald, 132 McGill St., Toronto

Mr. Cecil A. Larn, 40 College St., Toronto

The address of the evening was given by Dr. C. A. Chant, Director Emeritus of the David Dunlap Observatory, on "A Visit to the Astronomical Congress at Stockholm." Dr. Chant is a genial and friendly observer, therefore the voyage to Glasgow and its Exhibition, then to London, and from there to Gothenburg and Stockholm, as well as the various events and the meetings of the Congress became real and interesting to the members, as the lecturer, in his intimate way, described the visit.

Dr. P. M. Millman began his special course of short lectures on the general subject, "The Cosmic Yardstick", the first lecture being on "sizes". Dr. Millman proceeded to construct a scale which the members found novel and exceedingly helpful. Beginning with an object one centimetre in diameter as a unit, the scale goes both ways by powers of ten of the diameter so that at -13 we have electrons and atomic nuclei; while in the opposite direction at $+27$ we have the visible universe. Outstanding units of measurement were

indicated as follows: Angstrom (A) at —8, i.e., 10^{-8} centimetre; micron (μ) at —4; foot at a little more than +1; kilometer and mile near +5; astronomical unit at +13; light year at +18; megaparsec above +24; and at +27, the visible universe, i.e. the diameter of the visible universe may be taken as 10^{27} centimetres. Between the extremes were indicated the places of atoms, filterable viruses, bacteria, multicelled life, asteroids, planets, novae, clusters, galaxies, and clusters of galaxies; also there were indicated the lengths of various "rays", etc.

Mr. J. R. Collins read a note from Mr. Fred Topham regarding the recent eclipse of a star, and also of what seemed to be a change in the rim of the crater Plato as seen in a recent photograph he had taken of the moon.

The Recorder asked leave to express on behalf of the members their appreciation of the admirable lectures given by Dr. Chant and Dr. Millman, and also their gratitude for the most kind consideration on the part of the Director and staff of the David Dunlap Observatory in making possible the meeting of the Society at the observatory on the evening of October 11.

The Chairman asked Dr. Millman to kindly convey this expression to Dr. R. K. Young and his staff.

November 8, 1938.—The regular meeting was held at the usual time and place, Mr. E. J. A. Kennedy in the chair.

The following were elected members of the Society:

Mr. Alexander Davidson, 37 Simpson Avenue, Mimico
Mr. Frank H. Walker, 960 Gerrard St. E., Toronto
Mrs. Mary Mildon, 275 Keewatin Avenue, Toronto

The paper of the evening was given by Mr. J. R. Collins on "Some Fundamental Concepts in Astronomy". After pointing out the necessity for definition of terms used in scientific discussion, the lecturer went on to deal with certain properties of matter, discussing in a clear and careful manner gravitation, cohesion which holds particles of matter together with a force greater than gravitation, and other related questions of interest. The lecture ended with an inquiry as to the nature of gravitation pointing to the conclusion that gravitation is a "field" co-extensive with the universe.

After some general discussion, the chairman asked Dr. R. E. DeLury, of Ottawa, the immediate Past-President of the Society who was in the room, to address the meeting. Dr. DeLury responded by describing in a highly interesting way his effort to form a satisfactory picture of the material world in the light of the results of scientific investigation. The Chairman expressed the warm thanks of the meeting to Mr. Collins and Dr. DeLury.

Dr. P. M. Millman continued his course of short lectures on "The Cosmic Yardstick" with a lecture on "Distances", in which he constructed a scale by adopting as a unit a distance of 1 centimetre, and proceeding by decimal multiples. In this scale he indicated the approximate distances of various objects from an observer on the earth. At 5 in the scale is a distance of 1 kilometre.

In the neighbourhood of distance 7, meteors appear in the upper atmosphere. Between 10 and 15 are the moon and the other satellites, asteroids, comets, the sun and planets. Between 18 and 22 are found Proxima Centauri, Sirius, and a dozen more of the brighter stars. Between 20 and 22 are found open clusters, the Orion nebula, and planetary nebulæ. Between 22 and 23 are the Milky Way clouds and globular clusters. Between 23 and 24 are local galaxies; between 25 and 26 are clusters of galaxies. At about 26½ is the limit of the 100-inch telescope and at 27 is the limit of the 200-inch telescope.

D. W. Best, *Recorder.*

Members at Large elected since March 4, 1938

M. H. Goldsmith.....1006 Freeman St., New York City, N.Y.
H. A. Wark.....3626 Meadow Avenue, Cincinnati, Ohio.
Charles Marsh.....Todd School, Woodstock, Ill.
Waldo S. Reed.....45 Park Avenue, New York City, N.Y.
A. T. Hellberg.....Baltzarsgatan 29, Malmo, Sweden.
N. F. Wright.....8 East Central Avenue, Miami, Oklahama.
Ben F. Thompson.....917 Pine Avenue, Lynwood, Cal.
Armand Spitz.....Newton Square, Philadelphia, Pa.
Frank R. Reindl.....1593 Waverly Place, Memphis, Tenn.
Albert W. Ames.....1810 34th Avenue, Seattle, Wash.
Willy Ley.....32-18 79th Street, Jackson Heights, Long Island, N.Y.
H. A. W. Brown, M.D...Fort St. John, B.C.
N. W. D. Chrimes.....The Manse, 4 Sydney Rd., Cradley Heath, Staffs., England.
Gordon Rath.....Falconbridge, Ontario.
Sylvester Soroka.....31 Penn St., Kingston, Pa.
E. M. Lindsay.....Director, Armagh Observatory, Armagh, Northern Ireland.
A. R. Sumner.....113 Everitt Avenue, Hewlett, N.Y.

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